



MSC-23314-1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Christiansen et al.

Serial No.: 09/892,355

Filed: June 26, 2001

Title: Flexible Multi-Shock Shield

§
§
§
§
§
§
§

Examiner: Jordan M. Lofdahl

Group Art Unit: 3644

Commissioner for Patents
U.S. Patent and Trademark Office
P.O. Box 2327
Arlington, VA 22202

Dear Sir:

<p>CERTIFICATE OF MAILING UNDER 37 C.F.R. §1.8(a)</p> <p>I hereby certify that this correspondence is being deposited with the U.S. Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, U.S. Patent and Trademark Office, P.O. Box 2327, Arlington, VA 22202, on <u>July 29, 2003</u>.</p> <p>By: <u>James M. Cato</u></p> <p>Signature: <u>James M. Cato</u></p>
--

RECEIVED
AUG 6 2003
GROUP 360015/Deel
9/12/13
H. JonesDECLARATION UNDER 37 C.F.R. § 1.132

I, Lalit C. Chhabildas, hereby declare:

1. I am at least 18 years of age and am competent in all respects to make the following statements.
2. I live at 3716 Tewa Dr. N.E., Albuquerque, NM, 87111
3. I have a Bachelors Degree in Physics from The University of Bombay, INDIA; and a Doctorate in Physics from Rensselaer Polytechnic Institute, United States. I am a member of the American Physical Society (APS), Hypervelocity Impact Society (HVIS), Aeroballistics Range Association (ARA), and have been the President of the Hyper Velocity Impact Society, Chairman of the APS - Topical Group on Shock Compression of Condensed Matter, and am the Chairman of the Awards Committee of the APS - Topical Group on Shock Compression of Condensed Matter. For over 26 years, I have specialized in the field of hypervelocity impact. I have authored or co-authored over 350 technical articles in this field. My Curriculum Vitae is attached as Appendix A.

4. I consider myself to be a person of at least ordinary skill in the art of hypervelocity impact.

5. I am not now, nor have I ever been, in the employment of the assignee of the present application.

6. I have reviewed U.S. Patent No. 6,298,765 (Dvorak), entitled "Multi-shock Assembly for Protecting a Spacecraft Surface From Hypervelocity Impactors." Although the multi-shock shielding concept described in the patent is interesting, it is not readily apparent how a person of ordinary skill in my field would practically apply this shielding concept to spacecraft protection without a large investment in time, energy, and resource to assess how much shielding is required. For example, it is not readily apparent from the patent how a desired level of protection would be achieved for a particular shield design in terms of the particle mass, velocity, and angle that would just reach, but not exceed the failure threshold of the shield. In essence, the Dvorak patent does not contain sufficient information to teach a person of ordinary skill in my field how to effectively put the multi-shock shielding concept into practice.

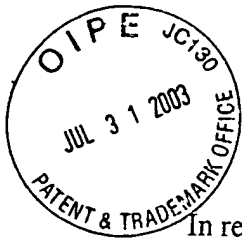
6. I have also reviewed the present application, with special attention to the mathematical relationships embodied in Equations 1-5 contained therein. In my opinion, these relationships are essential in order to teach a person of ordinary skill in my field how to successfully design the multi-shock shields described in the application to defend against particular threat particles (those of a given size, velocity, impact angle and density). Equations 1-5 are therefore necessary in real world applications of the multi-shock shielding concept to spacecraft protection from meteoroid and orbital debris particles with high confidence of success. The equations mathematically explain the physical process and the relevant parameters associated with the design and performance of the multi-shock shield. This is crucial in providing an efficient and predictive

process when changing materials in the design of advanced shielding concepts without an excess amount of experimentation.

7. Further, Equations 1-5 are not generally known to, nor can they be easily derived by, a person with my education, training, and experience. I hold this opinion because of my own efforts in developing similar equations on numerous projects such as developing constitutive relations for use in hydrodynamic codes for design and predictive tools for advanced concepts in armor and shielding. Based on my experience, equations such as Equations 1-5 cannot be developed by a person having ordinary skill in my field without having a considerable amount of data from actual tests and theoretical studies. The data must then be compiled and statistically analyzed, and mathematical models representing the data must be developed and verified. Only after extensive verification are the mathematical models set forth as equations. Such a process, based on my experience in the field of hypervelocity impact, is enormously expensive and time consuming.

8. I declare further that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such false statements may jeopardize the validity of the application or any patent issuing thereon. Executed on January 15th, 2003.

Lalit C. Chhabildas
Lalit C. Chhabildas



MSC-23314-1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Christiansen et al.

Serial No.: 09/892,355

Filed: June 26, 2001

Title: Flexible Multi-Shock Shield

§
§
§
§
§
§
§

Examiner: Jordan M. Eofdah

Group Art Unit: 3600

RECEIVED
JUL 06 2003
GROUP 3600

Commissioner for Patents
U.S. Patent and Trademark Office
P.O. Box 2327
Arlington, VA 22202

Dear Sir:

<p>CERTIFICATE OF MAILING UNDER 37 C.F.R. §1.8(a)</p> <p>I hereby certify that this correspondence is being deposited with the U.S. Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, U.S. Patent and Trademark Office, P.O. Box 2327, Arlington, VA 22202, on</p> <p><u>July 29, 2003</u></p> <p>By: <u>James M. Eofdah</u></p> <p>Signature: <u>James M. Eofdah</u></p>
--

DECLARATION UNDER 37 C.F.R. § 1.132

I, Charles E. Anderson, Jr., hereby declare:

1. I am at least 18 years of age and am competent in all respects to make the following statements.
2. I work at Southwest Research Institute, 6220 Culebra Road, San Antonio, TX, 78238
3. I have a Bachelors Degree in Physics from Virginia Polytechnic Institute & State University, and a Masters degree and a Ph. D. in Physics from Rensselaer Polytechnic Institute, United States. I am a member of the American Physical Society (APS), Hypervelocity Impact Society (HVIS), the International Ballistics Committee (IBC), Sigma Xi, and the American Association for the Advancement of Science (AAAS). I am active in the APS, and in particular, the Topical Group on Shock Compression in Condensed Matter, participating technically with scientific papers and organizationally as Session Chair at most of the topical conferences over the last 15 or so years. I was a founding Board member and the first president of the Hypervelocity Impact Society, and am

currently an elected member of the Board of Directors, having just been re-elected by the membership for a new 6-year term. I have over 30 years of experience in high-rate loading research, and have specialized in penetration mechanics, including hypervelocity impact, since approximately 1982. I have authored or co-authored over 170 technical articles, and over 90 technical reports. Further, because of my knowledge and expertise in penetration mechanics, I have been a member of several different “expert” or “Blue Ribbon” panels that have been formed by various U.S. Government organizations to review, assess and provide recommendations in the general area of high-rate loading and penetration/armor mechanics, including—but not limited to—hypervelocity impact. My Curriculum Vitae is attached as Appendix A.

4. I consider myself to be a person of at least ordinary skill, and probably an expert, in the art of hypervelocity impact.

5. I am not now, nor have I ever been, in the employment of the assignee of the present application.

6. I have reviewed U.S. Patent No. 6,298,765 (Dvorak), entitled “Multi-shock Assembly for Protecting a Spacecraft Surface From Hypervelocity Impactors.” Although the multi-shock shielding concept described in the patent has technical merit, the description is of only a general nature; and it is not readily apparent how a person of ordinary skill in my field would apply this shielding concept to spacecraft protection. The Multi-shock Assembly is comprised of a variety of modern, flexible materials such as Kevlar™, Spectra™, Nextel™ (fabric and foam), open-cell and/or closed-cell foams, etc. It is not apparent from the patent how these materials should be assembled to achieve a desired level of protection from the impact of a hypervelocity impactor that is characterized by its density, diameter, mass, velocity, and impact angle. The Dvorak patent does not contain sufficient information to teach a person of ordinary skill in my field how to put the multi-shock

shielding concept into practice without a large investment in time, energy, and resource to assess how much shielding is required to achieve a reliable level of protection.

6. I have also reviewed the present application, with special attention to the mathematical relationships embodied in Equations 1-5. These equations mathematically explain the physical process and the relevant parameters associated with the design and performance of the multi-shock shield (in terms of the areal density of the flexible shield layers and the areal density of the back wall, and spacing between the flexible shield and the back wall) to defend against particular threat impactors (described by their density, diameter, mass, velocity, and impact angle). In my opinion, these relationships are essential in order to teach a person of ordinary skill in my field how to successfully design the multi-shock shields described in the application.

7. Further, Equations 1-5 cannot be easily derived by a person with my education, training, and experience without considerable experimentation and analysis. I hold this opinion because of my own knowledge of efforts by investigators to develop shielding equations for hypervelocity impact from meteoroids and orbital debris. In particular, I have been the Guest Editor for seven (7) volumes—and I am currently editing an eighth volume—of the *Proceedings of the Hypervelocity Impact Symposia*, published in the peer reviewed ***International Journal of Impact Engineering***. Based on my experience and knowledge of the field, equations such as Equations 1-5 cannot be developed by a person having ordinary skill in my field without having assembled a considerable amount of experimental data from actual tests, perhaps supplemented by theoretical studies. These data must then be compiled and statistically analyzed, and mathematical models representing the data must be developed and verified. Only after extensive verification are the mathematical models set forth as engineering equations useful for design applications. Such a process, based on my experience in the field of hypervelocity impact, is enormously difficult and time

consuming.

8. In my opinion, Equations 1-5 are crucial in providing an efficient and predictive process when changing materials in the design of advanced shielding concepts without an excess amount of experimentation. Equations 1-5 are therefore necessary in real world applications of the multi-shock shielding concept to spacecraft protection from hypervelocity impact.

9. I declare further that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such false statements may jeopardize the validity of the application or any patent issuing thereon. Executed on 18 July, 2003.

Charles E. Andrus, Jr.

CHARLES E. ANDERSON, JR.
Director, Engineering Dynamics Department
Mechanical and Materials Engineering Division

B.S. in Physics, Virginia Polytechnic Institute, 1968
M.S. in Physics, Rensselaer Polytechnic Institute, 1972
Ph.D. in Physics, Rensselaer Polytechnic Institute, 1972

Dr. Anderson has worked extensively on modifying and improving the predictive capabilities of the large Eulerian and Lagrangian hydrocodes, and has used them for fundamental and applied analyses of warhead fragmentation effects, warhead concept development for ballistic missile defense, penetration mechanics, hypervelocity impact, and armor/anti-armor impact interactions. Dr. Anderson organized and is a lecturer for *A Short Course on Penetration Mechanics*, taught by the Institute. The course presents and develops the fundamental and underlying principles of penetration mechanics including experimental, analytical, and numerical approaches to penetration and perforation physics. He is coauthor of the course notes. Other active areas of research at SwRI have included the development of thermodynamic heat transfer model for intumescent (expanding) thermal protective systems, predictive modeling and analysis of highly transient thermal pulses from HE detonations within enclosures and rocket motor cookoff. More recently, Dr. Anderson has been involved in the development and assessment of advanced, lightweight armor concepts; and weapons effects on next-generation Navy ships (specifically, missile magazines and composite deck house).

In 1986, Dr. Anderson received a Technical Leadership Award for leading the development of an advanced capability in shock physics including the analytical and computational modeling of complex problems in high rate deformation mechanics. A second Technical Leadership Award was presented in 1995 for a vigorous high quality program in engineering dynamics and ballistics. Because of his acknowledged expertise in penetration and computational mechanics, Dr. Anderson has served on various Government advisory committees. In the fall of 1988, Dr. Anderson was the chairman of a Blue Ribbon Panel for DARPA to evaluate and make recommendations concerning the KE Impact Physics Program, with specific attention to hypervelocity impact. In 1989, he served on the DARPA/ONR/ARO Advisory Group on Constitutive Modeling for Large-Scale Numerical Computations of Nonlinear Behavior, and a DOD/DOE Advisory Group on Computational Computer Programs for Modeling Dynamic Material Response. In 1993-1994, Dr. Anderson participated in the Future Technologies Workshop conducted by ARL/TARDEC. Dr. Anderson and his co-authors won the Best Paper Award at the 1992 *Hypervelocity Impact Symposium*, and the Best Poster Award at the 17th *International Symposium on Ballistics* (1998). In 2000, Dr. Anderson received the *HVIS Distinguished Scientist Award*, given for significant and lasting contributions to the science of hypervelocity ballistics. In 2002, Dr. Anderson was appointed to the National Academies' *ARL Technical Assessment Board's Panel on Armor & Armaments*.

Dr. Anderson has authored numerous Government reports and has presented papers at national and international technical conferences and published extensively in the disciplines of computer simulations, the mechanics of high-rate loading response, and penetration mechanics including hypervelocity impact. A number of these articles are co-authored with internationally-known investigators from other research organizations. He was the Technical Program Chairman for the 1986 *Hypervelocity Impact Symposium (HVIS)*, 1989 *HVIS* and the 1992 *HVIS*; and is the editor of the proceedings for the 1986, 1989, 1992, 1994, 1996, 1998, and 2000 symposia which have been published as special volumes of *International Journal of Impact Engineering*. He is also the co-chairman of the 1999 *International Ballistics Symposium*. Dr. Anderson is listed in *American Men and Women in Science*, *Who's Who in the American Southwest*, *Who's Who in Science and Engineering*, *International Who's Who of Professionals*, and *Who's Who in the World*. Dr. Anderson is a member of the Editorial Advisory Board for the *International Journal of Impact Engineering*, a member of the *International Ballistics Committee*, and is a *Senior Institute Fellow* of the Institute for Advanced Technology of The University of Texas at Austin.

PROFESSIONAL CHRONOLOGY: Active Duty as U.S. Army Reserve Officer (1972-1974); Research Physicist, U.S. Army Ballistic Research Laboratories, Aberdeen Proving Ground, Maryland (1974-80); Southwest Research Institute (Senior Research Physicist, Department of Energetic Systems, 1980-1984; Manager, Dynamic Analysis Section, 1984-1988; Manager, Ballistic Sciences Section, 1988-1993; Director, Engineering Dynamics Department, 1994-).

MEMBERSHIPS: Sigma Xi; Association for the Advancement of Science; American Physical Society (Topical Group on Shock Waves in Condensed Matter), Hypervelocity Impact Society (Board of Directors, 1988-1994, 1996-present; President, 1989-1992; Past-President 1992-1994; Publications Chairman 1992-present).



SOUTHWEST RESEARCH INSTITUTE®

LIST OF PAPERS AND PRESENTATIONS

by

Charles E. Anderson, Jr.

1. "Quasi-Static Pressure, Duration, and Impulse for Explosions in Structures," by W. E. Baker, C. E. Anderson, Jr., B. L. Morris, and D. K. Wauters, 20th DoD Explosives Safety Seminar, Norfolk, VA, August 1982.
2. "Rail Tank Car Safety by Fire Protection," by C. E. Anderson, Jr., *6th Int. Fire Protection Seminar*, Karlsruhe, Germany, September 1982.
3. "A Parametric Analysis of the Penetration Process," by J. L. Rand, C. E. Anderson, Jr., and J. S. Wilbeck, *7th Int. Symp. on Ballistics*, The Hague, The Netherlands, April 1983.
4. "Quasi-Static Pressure, Duration and Impulse for Explosions (e.g., HE) in Structures," by C. E. Anderson, Jr., W. W. Baker, D. K. Wauters, and B. L. Morris, *Int. J. Mech. Sci.*, **25** (6), pp. 445-464, 1983.
5. "Thermodynamic Heat Transfer Model for Intumescent Coatings," by C. E. Anderson, Jr., D. K. Wauters, and D. F. Pulley, CPIA Publication 381, Vol. 1, Chemical Propulsion Information Agency, Laurel, MD, pp. 231-240, 1983.
6. "The Response of Intumescent Paints to Heat," by J. Buckmaster, C. Anderson, and A. Nachman, *Proc. Int. Colloquium on Free Boundary Problems*, Maubuisson, France, Pitman Publishing, Ltd., June 1984.
7. "A Model for Intumescent Systems," by J. Buckmaster, C. Anderson, and A. Nachman, *Int. Congress on Theoretical and Applied Mechanics*, Lyngby, Denmark, August 1984.
8. "A Thermodynamic Heat Transfer Model for Intumescent Systems," by C. E. Anderson, Jr., and D. K. Wauters, *Int. J. Engng Sci.*, **22** (7), pp. 881-889, 1984.
9. "Intumescent Reaction Mechanisms," by C. E. Anderson, Jr., J. Dziuk, W. A. Mallow, and J. Buckmaster, *J. Fire Sci.*, **3** (3), pp. 160-194, 1985.
10. "A Heuristic Predictive Model for the Failure of Composite Pressure Vessel Subjected to Laser Irradiation," by M. F. Kanninen, J. W. Cardinal, and C. E. Anderson, Jr., *AIAA Laser Effects and Target Response Meeting*, Menlo Park, November 5-7, 1985.
11. "Computational Modeling of Explosive-Filled Cylinders," by C. E. Anderson, Jr., W. W. Predebon, and R. R. Karpp, *Int. J. Engng. Sci.*, **23** (12), pp. 1317-1330, 1985.
12. "Sandia Shock Compression Database," by C. Anderson, J. Wilbeck, J. Hokanson, J. Asay, D. Grady, R. Graham, and M. Kipp, in **Shock Waves in Condensed Matter**, Plenum Press, pp. 185-190, 1986.
13. "A Model for Intumescent Paints," by J. Buckmaster, C. Anderson, and A. Nachman, *Int. J. Engng. Sci.*, **24** (3), pp. 263-276, 1986.
14. "Spread of Fire Effects Between Rooms: A Computational Model," by C. E. Anderson, Jr., D. K. O'Kelley, and A. F. Grand, *J. Fire Sci.*, **4** (6), pp. 365-396, 1986.
15. "The Sandia Computerized Shock Compression Bibliographical Database," by J. Wilbeck, C. Anderson, J. Hokanson, J. Asay, D. Grady, B. Graham, and M. Kipp, **Metallurgical Application of Shock-Wave and High-Strain-Rate Phenomena**, edited by Murr/Straudhammer and Meyers, Marcel Dekker, NY, pp. 357-367, 1986.

16. "A Fracture Mechanics Analysis for the Failure of Filament-Wound Pressurized Cylinders Subjected to Intense Energy Disposition," by C. E. Anderson, Jr., J. W. Cardinal, M. F. Kanninen, presented at the *Army Symp. Solid Mech. 1986*, West Point, NY, October, 1986.
17. "An Overview of the Theory of Hydrocodes," by C. E. Anderson, Jr., *Int. J. Impact Engng.*, **5** (1-4), pp. 33-59, 1987.
18. "History and Application of Hydrocodes in Hypervelocity Impact," by W. E. Johnson and C. E. Anderson, Jr., *Int. J. Impact Engng.*, **5** (1-4), pp. 423-439, 1987.
19. "The Status of Ballistic Impact Modeling," by C. E. Anderson, Jr., and S. R. Bodner, *Third TACOM Armor Coordinating Conference*, Vol. II, pp. 191-229, February 17-19, Monterey, CA, Battelle Columbus Division, Columbus, OH, 1987.
20. "Finite Element Analysis of Localized Mechanical Failure of Rocket Motors in the Cookoff Environment," by S. A. Mullin, P. A. Cox and C. E. Anderson, Jr., CPIA Publication 464, Vol. II, Chemical Propulsion Information System, Laurel, MD, 1987.
21. "Flyer Plate Impact of Dry Soils: An Instrumentation Calibration Technique," by C. E. Anderson, Jr., P. E. O'Donoghue, J. D. Renick and D. K. O'Kelley, *DNA Conference on Instrumentation for Nuclear Weapons Effects Testing*, October 6-8, Arlington, VA, 1987.
22. "Shock Propagation and Its Influence on Spall in Explosive Launching of Preformed Fragments," by P. E. O'Donoghue, C. E. Anderson, Jr., and W. W. Predebon, **Impact Loading and Dynamic Behavior of Materials**, Vol. II, edited by Chen, Kunze and Meyer, DGM Informationsgesellschaft, Oberursel, pp. 1041-1050, 1988.
23. "Flyer Plate Impact of Dry Soils: A Comparison of Analytic and Numerical Predictions," by P. E. O'Donoghue, C. E. Anderson, Jr., J. D. Renick and D. K. O'Kelley, **Shock Waves in Condensed Matter 1987**, edited by S. C. Schmidt and N. C. Holmes, Elsevier Science Publishers B.V., Amsterdam, pp. 239-242, 1988.
24. "Tensile Failure in Tungsten Alloy Fragments," by C. E. Anderson, Jr., P. E. O'Donoghue and S. R. Bodner, **Shock Waves in Condensed Matter 1987**, edited by S. C. Schmidt and N. C. Holmes, Elsevier Science Publishers B.V., Amsterdam, pp. 371-374, 1988.
25. "Gap Closure and Opening Between Preformed Fragments During Explosive Launch," by W. W. Predebon, P. E. O'Donoghue, and C. E. Anderson, Jr., **Shock Waves in Condensed Matter 1987**, edited by S. C. Schmidt and N. C. Holmes, Elsevier Science Publishers B.V., Amsterdam, pp. 729-732, 1988.
26. "Hypervelocity Impact Phenomenology: Debris Clouds," by C. E. Anderson, Jr. and S. A. Mullin, **Impact: Effects of Fast Transient Loadings**, edited by Ammann, et al, A.A. Balkema, Rotterdam, pp. 105-122, 1988.
27. "Dynamic Launch Process of Preformed Fragments," by P. E. O'Donoghue, W. W. Predebon and C. E. Anderson, Jr., *J. Appl. Phys.*, **63** (5), pp. 1428-1437, 1988.
28. "Calibration of Stress and Motion Instrumentation for Dry Soils," by J. D. Renick, C. E. Anderson, Jr., P. O'Donoghue, D. K. O'Kelley and C. Felice, *J. Appl. Phys.*, **63** (5), pp. 1428-1437, 1988.
29. "Ballistic Impact: The Status of Analytical and Numerical Modeling," by C. E. Anderson, Jr. and S. R. Bodner, *Int. J. Impact Engng.*, **7** (1), pp. 9-35, 1988.
30. "A Mixture Theory Approach to the Modeling of Fiber-Reinforced Composites Subject to Impulsive Loading," by P. E. O'Donoghue and C. E. Anderson, Jr., **Computational Mechanics - Theory and Applications**, edited by S. N. Atluri and G. Yagawa, Springer-Verlag, NY, pp. 20.iii. 1-4, 1988.

31. "Fracture of Tungsten Heavy Alloys Under Impulsive Loading Conditions," by J. Lankford, C. E. Anderson, Jr., and S. R. Bodner, *J. Mat. Sci. Lett.*, **7**, pp. 1355-1358, 1988.
32. "Constitutive Modeling of Soil for Uniaxial Strain Impact Experiments," by C. E. Anderson, Jr., P. E. O'Donoghue, and C. Felice, *7th ASCE/EMD Specialty Conference*, May 22-25, Blacksburg, VA, 1988.
33. "Initial Shock Phase of Penetration: Comparison of Analytical Predictions and Numerical Simulations," by C. E. Anderson, Jr., P. E. O'Donoghue, and S. R. Bodner, *25th Annual Meeting of the Society of Engineering Science*, June 20-21, University of California-Berkeley, 1988.
34. "Fracture of Discrete Tungsten Fragments Under Explosive Loading," by C. E. Anderson, Jr., P. E. O'Donoghue, and S. R. Bodner, *Int. J. Impact Engng.*, **7** (4), pp. 371-377, 1988.
35. "Thermal Conductivity of Intumescent Chars," by C. E. Anderson, Jr., D. E. Ketchum and W. P. Mountain, *J. Fire Sci.*, **6** (6), pp. 390-410, 1988.
36. "Shock Propagation and Damage in Explosively Launched Cubical Fragments," by C. E. Anderson, Jr., P. E. O'Donoghue, and S. R. Bodner, *Int. J. Impact Engng.*, **8** (1), pp. 69-81, 1989.
37. "Modeling the Shock Phase of Impact," by C. E. Anderson, Jr., J. P. Riegel, S. R. Bodner, and P. E. O'Donoghue, *Fifth TACOM Armor Coordinating Conference*, March 7-9, Monterey, CA, 1989.
38. "Evolutionary Damage Measures in Eulerian Hydrocodes," by W. W. Predebon, C. E. Anderson, Jr., J. D. Walker, and P. E. O'Donoghue, *2nd Post-SMIRT Conference on Impact*, August 21-22, Anaheim, CA, 1989.
39. "An Examination of the Wave Structure Generated at the Interface of Oblique Impact and Explosive Welds," by C. E. Anderson, Jr., J. D. Walker, J. Lankford, and P. E. O'Donoghue, *2nd Post-SMIRT Conference on Impact*, August 21-22, Anaheim, CA, 1989.
40. "Comparison of a High Velocity Impact Model with Numerical Simulation," by P. E. O'Donoghue, S. R. Bodner, C. E. Anderson, Jr., and M. Ravid, *Int. J. Impact Engng.*, **8** (4), pp. 289-301, 1989.
41. "Debris Cloud Dynamics," by C. E. Anderson, Jr., T. G. Trucano, and S. A. Mullin, *Int. J. Impact Engng.*, **9** (1), pp. 89-113, 1990.
42. "Anisotropic Model Development for Shock Applications," by C. E. Anderson, Jr., P. E. O'Donoghue and D. Skerhut, **Shock Compression in Condensed Matter 1989**, edited by S. C. Schmidt, J. N. Johnson, and L. W. Davison, Elsevier Science Publishers B.V., Amsterdam, pp. 177-180, 1990.
43. "Anisotropic Model Development for Shock Wave Propagation Computer Programs," by P. E. O'Donoghue, G. J. Friesenhahn, C. E. Anderson, Jr., and C. H. Parr, **Shock Compression in Condensed Matter 1989**, edited by S. C. Schmidt, J. N. Johnson, and L. W. Davison, Elsevier Science Publishers B.V., Amsterdam, pp. 181-184, 1990.
44. "Inclusion of Equivalent Plastic Strain in Eulerian Hydrocodes," by W. W. Predebon, C. E. Anderson, Jr., J. D. Walker and P. E. O'Donoghue, **Shock Compression in Condensed Matter 1989**, edited by S. C. Schmidt, J. N. Johnson, and L. W. Davison, Elsevier Science Publishers B.V., Amsterdam, pp. 185-189, 1990.
45. "Numerical Simulations of Split-Hopkinson Pressure Bar Compression Experiments," by J. D. Walker, C. E. Anderson, Jr., and J. Lankford, **Shock Compression in Condensed Matter 1989**, edited by S. C. Schmidt, J. N. Johnson, and L. W. Davison, Elsevier Science Publishers B.V., Amsterdam, pp. 225-228, 1990.
46. "A Mixture Theory Approach for the Shock Response of Composite Materials," by C. E. Anderson, Jr., P. E. O'Donoghue and D. Skerhut, *J. Comp. Mat.*, **24**, pp. 1159-1178, 1990.

47. "Dissimilar Material Velocity Scaling for Hypervelocity Impact," by S. A. Mullin, C. E. Anderson, Jr., J. S. Wilbeck and D. Apo, *1989 Hypervelocity Impact Symp., Classified Proceedings*, DARPA-T10-90-02, Southwest Research Institute, San Antonio, TX, April 1990.
48. "Evolutionary Damage Measures in Eulerian Wavecodes Gradient Effects," W. W. Predebon, C. E. Anderson, Jr., J. D. Walker, J. M. Stahler, and H. Li, *Int. Conf. on Mechanics, Physics, and Structure of Materials: A Celebration of Aristotle's 23 Centuries*, August 19-24, Thessaloniki, Greece, 1990.
49. "Impact Calculations of $L/D \leq 1$ Penetrators," by D. L. Orphal, C. E. Anderson, Jr., and R. R. Franzen, *Proc. 12th Int. Ballistics Symp.*, 1, pp. 458-464, San Antonio, TX, Oct. 30 - Nov. 1, 1990.
50. "Inclusion of Evolutionary Damage Measures in Eulerian Wavecodes," by W. W. Predebon, C. E. Anderson, Jr., and J. D. Walker, *Comp. Mech.*, 7 (4), pp. 221-236, 1991.
51. "Numerical Simulations of SHPB Experiments of Ceramics," by C. E. Anderson, Jr., P. E. O'Donoghue, J. Lankford, and J. Walker, *Proc. 1991 Combat Vehicle Survivability Symp.*, Vol. II, pp. 167-175, April 15-17, Gathersburg, MD, 1991.
52. "The Ballistic Performance of Confined Ceramic Tiles," by B. L. Morris and C. E. Anderson, Jr., *Proc. 1991 Combat Survivability Conf.*, Vol. II, pp. 235-244, April 15-17, Gathersburg, MD, 1991.
53. "Dynamic Compressive Failure of Ceramics Under Confinement," by J. Lankford, C. E. Anderson, Jr., G. R. Johnson, and T. J. Holmquist, *Proc. 1991 Combat Vehicle Survivability Conf.*, Vol. II, pp. 67-73, April 15-17, Gaithersburg, MD, 1991.
54. "An Examination of Long-Rod Penetration," by C. E. Anderson, Jr. and J. D. Walker, *Int. J. Impact Engng.*, Vol. 11, No. 4, pp. 481-501, 1991.
55. "The Application of Dissimilar Material Velocity Scaling to Hypervelocity Impacts on Spacecraft," by S. A. Mullin, D. L. Littlefield, C. E. Anderson, Jr., and N. T. Tsai, *Proc. 62nd Shock and Vibration Symp.*, Vol. IV, pp. 756-764, Springfield, VA, October 29-31, 1991.
56. "Numerical Examination of Long-Rod Penetration," by C. E. Anderson, Jr., *22nd Midwestern Mechanics Conference*, University of Missouri-Rolla, October 1991.
57. "The Role of Microstructure in Deformation and Failure of Tungsten Heavy Alloys," by J. Lankford, A. Bose, H. Couque, and C. E. Anderson, Jr., *Proc. 12th Army Symp. on Solid Mechanics*, S. S. Chou (Editor), pp. 117-138, Plymouth, MA, Nov. 1991.
58. "Ballistic Performance of Confined Al_2O_3 Ceramic Tiles," by C. E. Anderson, Jr., *Impact Test Methods for Characterization of Ceramic Materials for Armor Components*, December 17-18, Jet Propulsion Laboratory, CA, 1991.
59. "Strain-Rate Effects in Replica-Scale Model Experiments," by C. E. Anderson, Jr., S. A. Mullin, and C. J. Kuhlman, *Proc. 1992 Combat Vehicle Survivability Symp.*, Vol. I, pp. 41-48, March 31 - April 2, Gaithersburg, MD, 1992.
60. "Microstructural Dependence of High Strain Rate Deformation and Damage Development in Tungsten Heavy Alloys," by J. Lankford, H. Couque, A. Bose, and C. E. Anderson, Jr., in *Shock Waves and High-Strain Rate Phenomenon in Materials*, edited by M. Meyers, L. Murr, and K. Staudhammer, pp. 137-145, Marcel Dekker, NY, 1992.
61. "A Nonsteady-State Model for Penetration," by J. D. Walker and C. E. Anderson, Jr., *13th Int. Symp. on Ballistics*, Vol. 3, pp. 9-16, June 1-3, Stockholm, Sweden, 1992.
62. "Penetration by $L/D < 1$ Projectiles," by D. L. Orphal, C. E. Anderson, Jr., R. R. Franzen, J. D. Walker, and P. N. Schneidewind, *13th Int. Symp. on Ballistics*, Vol. 3, pp. 235-242, June 1-3, Stockholm, Sweden, 1992.

63. "The Influence of Projectile Nose Shape on the Shock Phase of Impact into Semi-Infinite Targets," by J. D. Walker and C. E. Anderson, Jr., **Shock Compression of Condensed Matter 1991**, edited by S. C. Schmidt, R. D. Dick, J. W. Forbes, and D. G. Torsker, Elsevier Science Publishers, B.V., pp. 943-946, 1992.
64. "Long-Rod Penetration and the Calculation of Target Resistance," by C. E. Anderson, Jr. and J. D. Walker, **Shock Compression of Condensed Matter 1991**, edited by S. C. Schmidt, R. D. Dick, J. W. Forbes, and D. G. Torsker, Elsevier Science Publishers, B.V., pp. 967-970, 1992.
65. "Numerical Simulations of SHPB Experiments for the Dynamic Compressive Strength and Failure of Ceramics," by C. E. Anderson, Jr., P. E. O'Donoghue, J. Lankford, and J. D. Walker, *Int. J. Fract.*, **55**, pp. 193-208, 1992.
66. "The Ballistic Performance of Confined Al_2O_3 Ceramic Tiles," by C. E. Anderson, Jr. and B. L. Morris, *Int. J. Impact Engng*, **12** (2), pp. 167-187, 1992.
67. "A Constitutive Formulation for Anisotropic Materials Suitable for Wave Propagation Computer Programs," by P. E. O'Donoghue, C. E. Anderson, Jr., G. J. Friesenhahn and C. H. Parr, *J. Comp. Mat.*, **26** (13), pp. 1860-1884, 1992.
68. "Target Resistance for Long-Rod Penetration into Semi-Infinite Targets," by C. E. Anderson, Jr., J. D. Walker, and G. E. Hauver, *Nuclear Engng. Design*, **138**, pp. 93-104, 1992.
69. "Velocity Scaling of Impacts into Spacecraft Targets at 8 to 15 km/s," by S. A. Mullin, D. L. Littlefield, and C. E. Anderson, Jr., *Proc. 1992 Hypervelocity Impact Symp.*, Vol. I, pp. 81-96, Institute for Advanced Technology, The University of Texas at Austin, November 1992.
70. "Depth-of-Penetration Studies," by R. R. Franzen, D. L. Orphal, and C. E. Anderson, Jr., *Proc. 1992 Hypervelocity Impact Symp.*, Vol. II, pp. 75-92, Institute for Advanced Technology, The University of Texas at Austin, November 1992.
71. "Computer Simulations of Strain-Rate Effects in Replica Scale Model Penetration Experiments," by C. E. Anderson, Jr., S. A. Mullin, and C. J. Kuhlman, *Int. J. Impact Engng.*, **13** (1), pp. 35-52, 1993.
72. "Long-Rod Penetration, Target Resistance, and Hypervelocity Impact," by C. E. Anderson, Jr., D. L. Littlefield, and J. D. Walker, *Int. J. Impact Engng*, **14** (1-4), pp. 1-12, 1993.
73. "Impact and Penetration by $L/D \leq 1$ Projectiles," by D. L. Orphal, C. E. Anderson, Jr., R. R. Franzen, J. D. Walker, P. N. Schneidewind, and M. E. Majerus, *Int. J. Impact Engng.*, **14** (1-4), pp. 551-560, 1993.
74. "Penetration of Hard Layers by Hypervelocity Rod Projectiles," by S. J. Bless and C. E. Anderson, Jr., *Int. J. Impact Engng.*, **14** (1-4), pp. 85-93, 1993.
75. "Prediction of Large Scale High Velocity Penetration Experiments on Ceramic Armor," by S. J. Bless, R. Subramanian, C. E. Anderson, Jr., and D. L. Littlefield, **Proc. 13th Army Symp. on Solid Mechanics**, S-C. Chu, D. D. Bartlett, Jr., T. W. Wright, and D. Iyer (Eds.), Plymouth, MA, August 17-19, 1993.
76. "A Time-Dependent Model for Long-Rod Penetration," by J. D. Walker and C. E. Anderson, **Proc. 13th Army Symp. on Solid Mechanics**, S-C. Chu, D. D. Bartlett, Jr., T. W. Wright, and D. Iyer (Eds.), Plymouth, MA, August 17-19, 1993.
77. "Penetration of Long Rods into Steel and Glass Targets: Experiments and Computations," by C. E. Anderson, Jr., V. Hohler, J. D. Walker, and A. J. Stilp, *Proc. 14th Int. Symp. on Ballistics*, Vol. 1, pp. 145-154, Québec, Canada, September 26-29, 1993.

78. "Prediction of Large Scale Impact Experiments on Steel Targets," by C. E. Anderson, Jr., S. J. Bless, D. L. Littlefield, and R. Subramanian, *Proc. 14th Int. Symp. on Ballistics*, Vol. 2, pp. 459-468, Québec, Canada, September 26-29, 1993.
79. "Post-Perforation Characteristics of Yawed Long Rods," by A. J. Piekutowski and C. E. Anderson, Jr., *Proc. 14th Int. Symp. on Ballistics*, Vol. 2, p. 527-536, Québec, Canada, September 26-29, 1993.
80. "The Influence of Initial Nose Shape in Eroding Penetration," by J. D. Walker and C. E. Anderson, Jr., *Int. J. Impact Engng.*, **15** (2), pp. 139-148, 1994.
81. "An Upper Limit for the Penetration Performance of Segmented Rods with Segment $L/D \leq 1$," by R. R. Franzen, J. D. Walker, D. L. Orphal, and C. E. Anderson, Jr., *Int. J. Impact Engng.*, **15** (5), pp. 661-668, 1994.
82. "The Penetration Performance of Short L/D Projectiles," by C. E. Anderson, Jr., D. L. Littlefield, N. W. Blaylock, S. J. Bless, and R. Subramanian, **High Pressure Science and Technology—1993**, (S. C. Schmidt, J. W. Shaner, G. A. Samara, and M. Ross, Eds.), pp. 1809-1812, AIP Press, Woodbury, NY, 1994.
83. "Analysis of Penetration of Steel and Al_2O_3 Targets," by D. L. Littlefield, C. E. Anderson, Jr., and S. R. Skaggs, **High Pressure Science and Technology—1993** (S. C. Schmidt, J. W. Shaner, G. A. Samara, and M. Ross, Eds.), pp. 1793-1796, AIP Press, Woodbury, NY, 1994.
84. "Multi-Material Velocities for Mixed Cells," by J. D. Walker and C. E. Anderson, Jr., **High Pressure Science and Technology—1993** (S. C. Schmidt, J. W. Shaner, G. A. Samara, and M. Ross, Eds.), pp. 1773-1777, AIP Press, Woodbury, NY, 1994.
85. "A Hypervelocity Experimental Research Database (HERD): Support for the Wright Laboratory Armament Directorate Code Validation Program (COVAL)," by S. A. Mullin, C. E. Anderson, Jr., E. S. Hetel, Jr., and R. D. Hunt, *AIAA Space Programs & Technologies Conference*, Huntsville, AL, September 27-29, 1994.
86. "Erosion Mechanisms Associated with Tungsten Alloy Penetration of Steel Targets," by J. Lankford, C. E. Anderson, Jr., S. A. Royal, and J. P. Riegel, III, *Dynamic Behavior of Materials*, Materials Week '94, TMS/AMS International, Rosemont, IL, Oct. 2-6, 1994.
87. "A Constitutive Formulation for Anisotropic Materials Suitable for Wave Propagation Computer Programs—II," by C. E. Anderson, Jr., P. A. Cox, G. R. Johnson, and P. J. Maudlin, *Comp. Mech.*, **15**, pp. 201-223, 1994.
88. "Time-Resolved Penetration of Long Rods into Steel Targets," by C. E. Anderson, Jr., V. Hohler, J. D. Walker, and A. J. Stilp, *Int. J. Impact Engng.*, **16**(1), pp. 1-18, 1995.
89. "A Time-Dependent Model for Long-Rod Penetration," by J. D. Walker and C. E. Anderson, Jr., *Int. J. Impact Engng.*, **16**(1), pp. 19-48, 1995.
90. "On the Velocity Dependence of the L/D Effect for Long-Rod Penetrators," by C. E. Anderson, Jr., J. D. Walker, S. J. Bless, and T. R. Sharron, *Int. J. Impact Engng.*, **17**, pp. 13-24, 1995.
91. "Variation of Crater Geometry with Projectile L/D for $L/D \geq 1$," by D. L. Orphal, C. E. Anderson, Jr., R. R. Franzen, and S. M. Babcock, *Int. J. Impact Engng.*, **17**, pp. 595-604, 1995.
92. "An Examination of Velocity Scaling," by S. A. Mullin, D. L. Littlefield, C. E. Anderson, Jr., and L. C. Chhabildas, *Int. J. Impact Engng.*, **17**, pp. 571-581, 1995.
93. "Behind Armor Debris Comparisons at Ordnance and Hypervelocities," by C. E. Anderson, Jr., S. J. Bless, T. R. Sharron, and R. Subramanian, *Proc. 6th Annual TARDEC Combat Vehicle Survivability Symp.*, Vol. I, pp. 313-322, Monterey, CA, March 28-30, 1995.

94. "Ballistic Performance of Confined 99.5% Al_2O_3 Ceramic Tiles," by C. E. Anderson, Jr., S. A. Royal, and B. L. Morris, *Proc. 6th Annual TARDEC Combat Vehicle Survivability Symp.*, Vol. I, pp. 111-120, Monterey, CA, March 28-30, 1995.
95. "Computational Modeling of Thin AD-85 Ceramic Tiles Backed by Thin Aluminum Substrates," by J. D. Walker, C. E. Anderson, Jr., and P. A. Cox, *Proc. 15th Int. Symp. on Ballistics*, Vol. 1, pp. 395-402, Jerusalem, Israel, May 21-24, 1995.
96. "Analysis of Behind Armor Debris at Two Impact Velocities," by C. E. Anderson, Jr., S. J. Bless, T. R. Sharron, and R. Subramanian, *Proc. 15th Int. Symp. on Ballistics*, Vol. 2, pp. 463-470, Jerusalem, Israel, May 21-24, 1995.
97. "The Effects of Radial Confinement on Penetration Efficiency in RHA Targets," by D. L. Littlefield, C. E. Anderson, Jr., Y. Partom, and S. J. Bless, *Proc. 15th Int. Symp. on Ballistics*, Vol. 1, pp. 91-98, Jerusalem, Israel, May 21-24, 1995.
98. "The Penetration of Non-Circular Cross-Section Penetrators," by S. J. Bless, D. L. Littlefield, and C. E. Anderson, Jr., *Proc. 15th Int. Symp. on Ballistics*, Vol. 1, pp. 43-50, Jerusalem, Israel, May 21-24, 1995.
99. "Ballistic Performance and Computations of Confined Al_2O_3 Ceramic Tiles," by C. E. Anderson, Jr., G. R. Johnson, and T. J. Holmquist, *Proc. 15th Int. Symp. on Ballistics*, Vol. 2, pp. 65-72, Jerusalem, Israel, May 21-24, 1995.
100. "Computational Modeling of Thin Ceramic Tiles Backed by Thin Substrates," by J. D. Walker, C. E. Anderson, Jr., and P. A. Cox, *Impact, Waves, and Fracture*, AMD-Vol. 205, pp. 375-390 (R. C. Batra, A. K. Mal, and G. P. MacSithigh, Eds.), ASME, New York, 1995.
101. "Large Confinement High Strain Rate Test Apparatus for Ceramics," by J. D. Walker, A. Nagy, C. E. Anderson, Jr., J. Lankford, and A. E. Nicholls, **Shock-Wave and High-Strain-Rate Phenomena** (L. E. Murr, K. P. Staudhammer, and M. A. Myers, Eds.), pp. 179-186, Elsevier Science, B.V., 1995.
102. "Scale Model Experiments with Ceramic Laminate Targets," by C. E. Anderson, Jr., S. A. Mullin, A. J. Piekutowski, N. W. Blaylock, and K. L. Poorman, *Int. J. Impact Engng.*, **18**(1), pp. 1-22, 1996.
103. "On the L/D Effect for Long-Rod Penetrators," by C. E. Anderson, Jr., J. D. Walker, S. J. Bless, and Y. Partom, *Int. J. Impact Engng.*, **18**(3), pp. 247-264, 1996.
104. "Penetration Erosion Phenomenology," by J. Lankford, C. E. Anderson, Jr., S. A. Royal, and J. P. Riegel, III, *Int. J. Impact Engng.*, **18**(5), pp. 565-578, 1996.
105. "A Study of Zoning Requirements for 2-D and 3-D Long-Rod Penetration," by D. L. Littlefield and C. E. Anderson, Jr., **Shock Compression in Condensed Matter—1995** (S. C. Schmidt and W. C. Tao, Eds.), pp. 1131-1134, AIP Press, Woodbury, NY, 1996.
106. "An Analytic Expression for P/L for WA Long Rods into Armor Steel," by C. E. Anderson, Jr. and J. D. Walker, **Shock Compression in Condensed Matter—1995** (S. C. Schmidt and W. C. Tao, Eds.), pp. 1135-1138, AIP Press, Woodbury, NY, 1996.
107. "Hydrodynamic Ram: A Benchmark Suite," by C. J. Freitas, C. E. Anderson, Jr., J. D. Walker, and D. L. Littlefield, *Structures Under Extreme Loading—1996*, (Y. S. Shim and J. A. Zukas, Eds.), pp. 63-74, PVP-Vol. 325, ASME, NY, 1996.
108. "Numerical Estimate of FATEPEN Fragmentation Parameters: Cube Against Composite Plate," by C. E. Anderson, Jr., and J. D. Walker, *JTCG/AS Methodology Subgroup Meeting*, Chicago, IL, Sept. 10-11, 1996.

109. "In-Situ Measurement of Penetrator Erosion Rate and Dynamic Flow Stress During Long-Rod Penetration," by A. L. Chang and C. E. Anderson, Jr., *Proc. 16th Int. Symp. on Ballistics*, Vol. 3, pp. 359-368, San Francisco, CA, 23-28 Sept. 1996.
110. "An Analytical Model for Ceramic-Faced Light Armors," by J. D. Walker and C. E. Anderson, Jr., *Proc. 16th Int. Symp. on Ballistics*, Vol. 3, pp. 289-298, San Francisco, CA, 23-28 Sept. 1996.
111. "The Influence of Projectile Hardness on Ballistic Limit Velocities," by C. E. Anderson, Jr., V. Hohler, J. D. Walker, and A. J. Stilp, *Proc. 16th Int. Symp. on Ballistics*, Vol. 3, pp. 279-288, San Francisco, CA, 23-28 Sept. 1996.
112. "Modified Cavity Expansion Analysis for Modeling Finite Target Penetration," by M. J. Normandia, S. Satapathy, D. L. Littlefield, and C. E. Anderson, Jr., *Proc. 16th Int. Symp. on Ballistics*, Vol. 3, pp. 219-228, San Francisco, CA, 23-28 Sept. 1996.
113. "Penetration Mechanics of Seg-Tel Penetrators," by C. E. Anderson, Jr., R. Subramanian, J. D. Walker, M. J. Normandia, and T. R. Sharron, *Int. J. Impact Engng.*, **20**, pp. 13-26, 1997.
114. "Modeling Long-Rod Penetration into Glass Targets," by C. E. Anderson, Jr., V. Hohler, J. D. Walker, and A. J. Stilp, *14th U. S. Army Symp. on Solid Mech.*, (K. R. Iyer and S.-C. Chou, Eds.), pp. 129-136, Battelle Press, Columbus, OH, 1997.
115. "The Role of Plasticity in the Failure of Impacted Ceramics," by J. Lankford and C. E. Anderson, Jr., *14th U. S. Army Symp. on Solid Mech.*, (K. R. Iyer and S.-C. Chou, Eds.), pp. 49-56, Battelle Press, Columbus, OH, 1997.
116. "The Penetration of Steel Targets Finite in Radial Extent," by D. L. Littlefield, C. E. Anderson, Jr., Y. Partom, and S. J. Bless, *Int. J. Impact Engng.*, **19**(1), pp. 49-62, 1997.
117. "The Role of Plasticity in Penetration Mechanics," by C. E. Anderson, Jr. and J. D. Walker, *Int. Conf. on Plasticity*, Juneau, AK, July 14-19, 1997.
118. "An Analytic Penetration Model for a Drucker-Prager Yield Surface with Cutoff," by J. D. Walker and C. E. Anderson, Jr., *Int. Conf. on Plasticity*, Juneau, AK, July 14-19, 1997.
119. "Ballistic Performance of Confined 99.5%-Al₂O₃ Ceramic Tiles," by C. E. Anderson, Jr. and S. A. Royal-Timmons, *Int. J. Impact Engng.*, **19**(8), pp. 703-713, 1997.
120. "The Influence of Experimental Design on Depth-of-Penetration (DOP) Test Results and Derived Ballistic Efficiencies," by R. R. Franzen, D. L. Orphal, and C. E. Anderson, Jr., *Int. J. Impact Engng.*, **19**(8), pp. 727-737, 1997.
121. "Penetration Modeling of Ceramic and Metal Targets," by J. D. Walker and C. E. Anderson, Jr., *36th Aerospace Sciences Meeting & Exhibit*, AIAA 98-0829, Reno, NV, January 12-15, 1998.
122. "The Influence of Edge Effects on Penetration," by C. E. Anderson, Jr., J. D. Walker, and T. R. Sharron, *Proc. 17th Int. Symp. on Ballistics*, Vol. 3, pp. 33-40, Midrand, South Africa, March 23-27, 1998.
123. "Modification of the Walker-Anderson Penetration Model to Include Exit Failure Modes and Fragmentation," by M. Ravid, S. R. Bodner, J. D. Walker, S. Chocron, C. E. Anderson, Jr., and J. R. Riegel, III, *Proc. 17th Int. Symp. on Ballistics*, Vol. 3, pp. 267-274, Midrand, South Africa, March 23-27, 1998.
124. "An Analytical Model for a Ceramic Tile, Substrate, and Fabric," by J. D. Walker and C. E. Anderson, Jr., *Proc. 17th Int. Symp. on Ballistics*, Vol. 3, pp. 65-72, Midrand, South Africa, March 23-27, 1998.

125. "Long-Rod Penetration: Cylindrical vs. Spherical Cavity Expansion for Extent of Plastic Flow," by S. Chocron, C. E. Anderson, Jr., and J. D. Walker, *Proc. 17th Int. Symp. on Ballistics*, Vol. 3, pp. 319-326, Midrand, South Africa, March 23-27, 1998.
126. "Optimization Using a Light Armor Model," by J. D. Walker and C. E. Anderson, Jr., *Proc. 17th Int. Symp. on Ballistics*, Vol. 3, pp. 375-382, Midrand, South Africa, March 23-27, 1998.
127. "Normalized Residual Lengths and Velocities as a Function of Projectile Strain-to-Failure," by C. E. Anderson, Jr. and J. D. Walker, *Proc. 17th Int. Symp. on Ballistics*, Vol. 3, pp. 427-433, Midrand, South Africa, March 23-27, 1998.
128. "Inelastic Response of Confined Aluminum Oxide under Dynamic Loading Conditions," by J. Lankford, C. E. Anderson, Jr., A. J. Nagy, J. D. Walker, A. E. Nicholls, and R. A. Page, *J. Mat. Sci.*, **33**(6), 1619-1625, 1998.
129. "An Analytical Model for a Drucker-Prager Yield Surface with Cutoff," by J. D. Walker and C. E. Anderson, Jr., **Shock Compression of Condensed Matter—1997**, (S. C. Schmidt, D. P. Dandekar, and J. W. Forbes, Eds.), pp. 897-900, AIP Press, Woodbury, NY, 1998.
130. "Investigation of Yawed Impact into a Finite Target," by C. E. Anderson, Jr., S. J. Bless, T. R. Sharron, S. Satapathy, and M. Normandia, **Shock Compression of Condensed Matter—1997**, (S. C. Schmidt, D. P. Dandekar, and J. W. Forbes, Eds.), pp. 925-928, AIP Press, Woodbury, NY, 1998.
131. "Numerical Simulations of a Hydrodynamic Ram Experiment," by C. E. Anderson, Jr., T. R. Sharron, J. D. Walker, and C. J. Freitas, *Proc. Transient Loading and Response of Structures Symp.*, pp. 333-352 (M. Langseth and T. Krauthammer, Eds.), Trondheim, Norway, May 25-27, 1998.
132. "A Numerical Study of a Hydrodynamic Ram Benchmark Experiment," by C. J. Freitas, C. E. Anderson, Jr., and J. D. Walker, *Symp. on Structures Under Extreme Loading—1998*, PVP-Vol. 361, pp. 139-156, ASME, New York, NY, July 1998.
133. "The Penetration of Asymmetric Long-Rod Projectiles at 2.6 km/s," by D. L. Littlefield, C. E. Anderson, Jr., and S. J. Bless, *Int. J. Impact Engng.*, **21**(8), 625-643, 1998.
134. "On the Hydrodynamic Approximation for Long-Rod Penetration," by C. E. Anderson, Jr., D. L. Orphal, R. R. Franzen, and J. D. Walker, *Society of Engineering Science Annual Technical Meeting*, Pullman, WA, Sept 27-30, 1998.
135. "The Role of Plasticity as a Limiting Factor in the Compressive Failure of High Strength Ceramics," by J. Lankford, W. W. Predebon, J. M. Staehler, G. Subhash, B. J. Pletka, and C. E. Anderson, Jr., *Mechanics of Materials*, **29**, 205-218, 1998.
136. "On the Hydrodynamic Approximation for Long-Rod Penetration," by C. E. Anderson, Jr., D. L. Orphal, R. R. Franzen, and J. D. Walker, *Int. J. Impact Engng.*, **22**(1), 23-42, 1999.
137. "Ceramic Dwell and Defeat of the 0.30-Cal AP Projectile," by C. E. Anderson, Jr. and J. D. Walker, *15th US Army Solid Mech. Symp.*, Mrytle Beach, SC, April 12-14, 1999.
138. "Dynamic Fracture Mechanics Computational Modeling with a Hydrocode," by C. H. Popelar, C. E. Anderson, Jr., J. D. Walker, G. R. Johnson, and S. R. Beissel, *ECCM '99* (European Conference on Computational Mechanics), Munich, Germany, August 31-September 3, 1999.
139. "The Influence of Projectile Hardness on Ballistic Performance," by C. E. Anderson, Jr., V. Hohler, J. D. Walker, and A. J. Stilp, *Int. J. Impact Engng.*, **22**(6), 619-632, 1999.
140. "Simulation and Analysis of a 23-mm HEI Projectile Hydrodynamic Ram Experiment," by C. E. Anderson, Jr., T. R. Sharron, James D. Walker, and Christopher J. Freitas, *Int. J. Impact Engng.*, **22**(9/10), 981-997, 1999.

141. "Analytical and Numerical Simulation of the Impact of the 0.30-Cal APM2 Projectile Against the Edge of a Metallic Target," by S. Chocron, C. E. Anderson, Jr., D. J. Grosch, and C. H. Popelar, *Proc. 18th Int. Symp. on Ballistics*, Vol. 2, pp. 753-760, Technomic Publishing Company, Inc., Lancaster, PA, 1999.
142. "A Consistent Plastic Flow Approach to Model Penetration and Failure of Finite-Thickness Metallic Targets," by S. Chocron, C. E. Anderson, Jr., and J. D. Walker, *Proc. 18th Int. Symp. on Ballistics*, Vol. 2, pp. 761-768, Technomic Publishing Company, Inc., Lancaster, PA, 1999.
143. DOP and V_{50} Predictions for the 0.30-Cal APM2 Projectile," by S. Chocron, D. J. Grosch, and C. E. Anderson, Jr., *Proc. 18th Int. Symp. on Ballistics*, Vol. 2, pp. 769-776, Technomic Publishing Company, Inc., Lancaster, PA, 1999.
144. "Revisiting R_t ," by Y. Partom, C. E. Anderson, Jr., and D. L. Orphal, *Proc. 18th Int. Symp. on Ballistics*, Vol. 2, pp. 1081-1088, Technomic Publishing Company, Inc., Lancaster, PA, 1999.
145. "Long-Rod Penetration into Highly Oblique, Water-Filled Targets," by C. E. Anderson, Jr., J. S. Wilbeck, and J. S. Elder, *Int. J. Impact Engng.*, **23**, 1-12, 1999.
146. "Streamline Reversal in Hypervelocity Penetration," by D. L. Orphal and C. E. Anderson, Jr., *Int. J. Impact Engng.*, **23**, 699-710, 1999.
147. "A Novel Method for Determining Dynamic Fracture Toughness," by C. E. Anderson, Jr., C. H. Popelar, A. Nagy, and J. D. Walker, **Shock Compression in Condensed Matter-1999**, (M. D. Furnish, L. C. Chhabildas, and R. S. Hixson, Eds.), pp. 505-508, AIP Press, Woodbury, NY, 2000.
148. "Further Investigation of the Target Resistance Penetration Parameter R_t ," by Y. Partom, C. E. Anderson, Jr., D. L. Orphal, **Shock Compression in Condensed Matter-1999**, (M. D. Furnish, L. C. Chhabildas, and R. S. Hixson, Eds.), pp. 1129-1132, AIP Press, Woodbury, NY, 2000.
149. "Ceramic Dwell: An Analytical Model," by C. E. Anderson, Jr. and J. D. Walker, *Advanced in Computational Engineering & Sciences*, (S. N. Atluri and F. W. Brust, Eds.), Vol. 1, pp. 390-395, Tech Science Press, Palmdale, CA, 2000.
150. "Modeling Penetration of Long Rods into Glass Targets," by C. E. Anderson, Jr. and J. D. Walker, *Advanced in Computational Engineering & Sciences*, (S. N. Atluri and F. W. Brust, Eds.), Vol. 1, pp. 408-413, Tech Science Press, Palmdale, CA, 2000.
151. "An Experimental Method for Determining Dynamic Fracture Toughness," by C. H. Popelar, C. E. Anderson, Jr., and A. Nagy, *Experimental Mechanics*, **40**(4), 401-407, 2000.
152. "Impact of the 7.62-mm APM2 Projectile Against the Edge of a Metallic Target," by S. Chocron, C. E. Anderson, Jr., D. J. Grosch, and C. H. Popelar, *Int. J. Impact Engng.*, **25**(5), 423-437, 2001.
153. "Time-Resolved Penetration of B_4C Tiles by the APM2 Bullet," by C. E. Anderson, Jr., J. D. Walker, and W. A. Gooch, *12th Annual TARDEC Ground Vehicle Survivability Symposium*, Monterey, CA, 26-29 March 2001.
154. "Residual Penetration of Rod Fragments after AP Interaction: An Analytical Model," by D. L. Goodlin, J. D. Walker, and C. E. Anderson, Jr., *12th Annual TARDEC Ground Vehicle Survivability Symposium*, Monterey, CA, 26-29 March 2001.
155. "Tungsten into Steel Penetration Including Velocity, L/D , and Impact Inclination Effects," by J. D. Walker, C. E. Anderson, Jr., and D. L. Goodlin, *Proc. 19th Int. Symp. on Ballistics*, Vol. III, pp. 1133-1140, Interlaken, Switzerland, May 7-11, 2001.
156. "Analytical Model of Long Rod Interaction with Spaced-Plate Targets," by S. Chocron, C. E. Anderson, Jr., and J. D. Walker, *Proc. 19th Int. Symp. on Ballistics*, Vol. III, pp. 1167-1174, Interlaken, Switzerland, May 7-11, 2001.

157. "Penetration of AP Projectiles into Spaced Ceramic Targets," by Y. Partom, C. E. Anderson, Jr., and D. Yaziv, *Proc. 19th Int. Symp. on Ballistics*, Vol. III, pp. 1175-1181, Interlaken, Switzerland, May 7-11, 2001.
158. "Oblique Penetration in Ceramic Targets," by D. Yaziv, S. Chocron, C. E. Anderson, Jr., and D. J. Grosch, *Proc. 19th Int. Symp. on Ballistics*, Vol. III, pp. 1257-1264, Interlaken, Switzerland, May 7-11, 2001.
159. "Numerical Simulations of Dynamic X-Ray Imaging Experiments of 7.62-mm APM2 Projectiles Penetrating B₄C," by C. E. Anderson, Jr. and W. A. Gooch, *Proc. 19th Int. Symp. on Ballistics*, Vol. III, pp. 1423-1429, Interlaken, Switzerland, May 7-11, 2001.
160. "Time-Resolved Penetration of B₄C Tiles by the APM2 Bullet, and Ceramic Dwell", by C. E. Anderson, Jr., J. D. Walker, M. S. Burkins, and W. A. Gooch, *US-Germany Armor/Anti-Armor Workshop*, Dresden, Germany, 3-6 July 2001.
161. "Residual Threat Analysis of Broken Long-Rod Projectiles," by C. E. Anderson, Jr., J. D. Walker, and D. L. Goodlin, *US-Germany Armor/Anti-Armor Workshop*, Dresden, Germany, 3-6 July 2001.
162. "Modeling the Ballistic Impact Performance of Two Aluminum Alloys," by K. A. Dannemann, C. E. Anderson, Jr., and G. R. Johnson, *Modeling the Performance of Engineering Structural Materials II*, (D. R. Leseur and T. S. Srivatsan, Ed), pp. 63-74, TMS, Warrendale, PA, November 2001.
163. "Target Damage from Highly Oblique Hypervelocity Impacts of Steel Spheres Against Thin Laminate Targets," by D. L. Orphal and C. E. Anderson, Jr., *Int. J. Impact Engng.*, **26**, pp. 567-578, December 2001.
164. "Deformation and Damage of Two Aluminum Alloys from Ballistic Impact," by C. E. Anderson, Jr. and K. A. Dannemann, *Shock Compression of Condensed Matter-2001*, (M. Furnish, N. N. Thadhani, and Y. Horie, Ed), pp. 1298-1301, American Institute of Physics, Melville, NY, 2002.
165. "Anisotropic Failure Model Development and Implementation," by J. D. Walker, K. A. Dannemann, and C. E. Anderson, Jr., *Shock Compression of Condensed Matter-2001*, (M. Furnish, N. N. Thadhani, and Y. Horie, Ed), pp. 275-278, American Institute of Physics, Melville, NY, 2002.
166. "Ballistic Response of Fabrics: Model and Experiments," by D. L. Orphal, J. D. Walker, and C. E. Anderson, Jr., *Shock Compression of Condensed Matter-2001*, (M. Furnish, N. N. Thadhani, and Y. Horie, Ed), pp. 1279-1282, American Institute of Physics, Melville, NY, 2002.
167. "Time-Resolved Penetration of B₄C Tiles by the APM2 Bullet," by C. E. Anderson, Jr., M. S. Burkins, J. D. Walker, and W. A. Gooch, submitted for publication.
168. "Experimental Analysis of the Debris Field Resulting from Prototype AP System/Threat Interaction," by D. L. Goodlin and C. E. Anderson, Jr., *13th Annual TARDEC Ground Survivability Symposium*, Naval Postgraduate School, Monterey, CA, 8-11 April 2002.
169. "Sensitivity Analysis of Effector-Projectile Interaction," by C. E. Anderson, Jr., D. L. Goodlin, and R. L. Mason, *13th Annual TARDEC Ground Survivability Symposium*, Naval Postgraduate School, Monterey, CA, 8-11 April 2002.
170. "Influence of Yaw Angle on the Penetration Reduction of Long Rods in Oblique Targets," by Th. Behner, V. Hohler, C. E. Anderson, Jr., and D. L. Goodlin, *Proc. 20th Int. Symp. on Ballistics*, Orlando, FL, Sept. 2002.
171. "Analytic Penetration Model for Ceramics," by S. Chocron, C. E. Anderson, Jr., and J. D. Walker, *Proc. 20th Int. Symp. on Ballistics*, Orlando, FL, Sept. 2002.

172. "Developing an Ultra-Lightweight Armor Concept," by C. E. Anderson, Jr., *Ceramic Transactions*, Volume 134, *Ceramic Armor Materials by Design*, (Edited by J. McCauley, et al), The American Ceramic Society, Westerville, OH, pp. 485-498, 2002.
173. "A Unified Model for Long-Rod Penetration in Multiple Metallic Target Plates," by S. Chocron, C. E. Anderson, Jr., J. D. Walker, and M. Ravid, *Int. J. Impact Engng.*, **28**(4), 391-411, 2003.
174. "Analysis of the Terminal Phase of Penetration," by C. E. Anderson, Jr. and D. L. Orphal, *Int. J. Impact Engng.*, to be published, 2003.
175. "Experimental Analysis of the Debris Field Resulting from Prototype AP System/Threat Interaction—II," by D. J. Grosch, D. L. Goodlin, and C. E. Anderson, Jr., *13th Annual TARDEC Ground Survivability Symposium*, Naval Postgraduate School, Monterey, CA, 7-10 April 2003.
176. "Reexamination of the Requirements to Detect the Failure Wave Velocity in SiC Using Penetration Experiments," by C. E. Anderson, Jr., D. L. Orphal, and D. W. Templeton, *APS Shock Physics Conference*, 21-25 July, Portland, OR 2003.
177. "Crater Diameter for $L/D = 1$ Like-Material Impacts on Semi-Infinite Targets," by D. L. Orphal and C. E. Anderson, Jr., *APS Shock Physics Conference*, 21-25 July, Portland, OR 2003.

LIST OF REPORTS

by

Charles E. Anderson, Jr.

1. "Method for Scaling X-Ray Energy Flux Inside Target to Long Ranges from a Source in Air," by W. Wright and C. Anderson, BRL Technical Note 1720, Ballistic Research Laboratory, Aberdeen Proving Ground, MD, September 1969.
2. "Railroad Tank Car Test, Test No. 6, by C. Anderson, W. Townsend, and J. Zook, BRL IMR No. 131, Ballistic Research Laboratory, Aberdeen Proving Ground, MD, August 1973; Report No. FRA-OR and D75-36, Federal Railroad Administration, Department of Transportation, Washington, D.C., 1975.
3. "Railroad Tank Car Fire Test, Test No. 7," by C. Anderson, W. Townsend, J. Zook, W. Wright, and G. Cowgill, BRL IMR No. 156, Ballistic Research Laboratory, Aberdeen Proving Ground, MD, December 1973; Report No. FRA-OR and D75-37, Federal Railroad Administration, Department of Transportation, Washington, D.C., 1975.
4. "Fragmentation and Metallurgical Analysis of Tank Car RAX201," by C. Anderson and E. Norris, BRL IMR No. 213, Ballistic Research Laboratory, Aberdeen Proving Ground, MD, April 1975; Report No. FRA-OR and D75-30, Federal Railroad Administration, Department of Transportation, Washington, D.C., 1975.
5. "Comparison of Thermally Coated and Uninsulated Rail Tank Cars Filled with LPG Subjected to a Fire Environment," by C. Anderson, W. Townsend, J. Zook, and G. Cowgill, BRL IMR No. 319, Ballistic Research Laboratory, Aberdeen Proving Ground, MD, December 1974; Report No. FRA-OR and D75-32, Federal Railroad Administration, Department of Transportation, Washington, D.C., 1975.
6. "The Effects of a Fire Environment on a Rail Tank Car Filled with LPG," by C. Anderson, W. Townsend, J. Zook, and G. Cowgill, BRL IMR 288, Ballistic Research Laboratory, Aberdeen Proving Ground, MD, September 1974; Report No. FRA-OR and D75-31, Federal Railroad Administration, Department of Transportation, Washington, D.C., 1975.
7. "Comparison of Various Thermal Systems for the Protection of Rail Tank Cards Tested at the FRA/BRL Torching Facility," by C. Anderson, W. Townsend, R. Markland, and J. Zook, BRL IMR No. 459, Ballistic Research Laboratory, Aberdeen Proving Ground, MD, December 1975.
8. "The Effects of a Fire Environment on a Rail Tank Car Filled with LPG," by C. Anderson, W. Townsend, J. Zook, and G. Cowgill, BRL Report No. 1935, Ballistic Research Laboratory, Aberdeen Proving Ground, MD, September 1976.
9. "Viscous Damping of a Crystal Oscillator," by C. E. Anderson, Jr., U.S. Army Electronics Command (ERAD-COM), Ft. Monmouth, NJ, 1976.
10. "Missile Warhead Modeling: Computations and Experiments," by W. W. Predebon, W. G. Smothers, and C. E. Anderson, Jr., BRL Report No. 2796, Ballistic Research Laboratory, Aberdeen Proving Ground, MD, October 1977.
11. "Interim Results of the Accelerated Life Test of Hazardous Material Tank Cars," by M. R. Johnson, C. E. Anderson, Jr., and J. E. Thompson, BRL IMR No. 664, Ballistic Research Laboratory, Aberdeen Proving Ground, MD, October 1979.

12. "SHOTFRAG Users Guide," by G. Randers-Pehrson, R. R. Karpp, C. E. Anderson, Jr., H. J. Blische, ARBRL-MR-03007, Ballistic Research Laboratory, Aberdeen Proving Ground, MD, March 1980.
13. "Results of the Accelerated Life Test of Hazardous Material Tank Cars," by M. R. Johnson, C. E. Anderson, Jr., and J. E. Thompson, BRL Report, Ballistic Research Laboratory, Aberdeen Proving Ground, MD, 1980.
14. "Methodology and Procedures for Automatic Computation of Depletion Depth and Carrier Concentration for Gas as Substrate materials," by C. E. Anderson, Jr., Electronic Technology and Devices Laboratory, ERADCOM, Ft. Monmouth, NJ, 1980.
15. "X-Ray Automatic Time Delay Device for Flash X-Ray Systems," by D. F. Merritt and C. E. Anderson, Jr., ARBRL-TR-02284, Ballistic Research Laboratory, Aberdeen Proving Ground, MD, January 1981.
16. "Rationale for Generic Evaluation of Tank Car Thermal Protective Systems," by C. E. Anderson, Jr., SwRI Final Report 06-6426, U. S. Army Ballistic Research Laboratory, Aberdeen Proving Ground, MD, July 1981.
17. "BMD Impact Phenomenology Data Base: Bibliography," by J. S. Wilbeck, J. L. Rand, and C. E. Anderson, Jr., SwRI Final Report 06-6567, Ballistic Missile Defense Advanced Technology Center, Huntsville, AL, July 1982.
18. "Determination of Blast Loads in the Damaged Weapons Facility: Vol. 1, Final Report for Phase II," by J. Hokanson, E. Esparza, W. Baker, N. Sandoval, and C. Anderson, SwRI Final Report 06-6578, Mason and Hanger-Silas Mason Company, Inc., Pantex Plant, Amarillo, TX, October 1982.
19. "Analysis of the BRL/FRA Drop Hammer Facility," by C. E. Anderson, Jr., J. W. Cardinal, J. L. Rand, and J. S. Wilbeck, SwRI Final Report 06-6970, Micro-Tec Service Company, Conowingo, MD, October 1982.
20. "Tank Car Head Shield Fatigue Evaluation," by C. E. Anderson, Jr. and W. Jackson, ARBRL-MR-03209, Ballistic Research Laboratory, Aberdeen Proving Ground, MD, November 1982.
21. "Computation Modeling of Warhead Fragment Velocities," by C. E. Anderson, Jr. and D. K. Wauters, SwRI Internal Research Final Report, December 1982.
22. "Intumescent Reaction Mechanisms: An Analytic Model," by C. E. Anderson, Jr., and D. K. Wauters, Report NADC-82211-60, SwRI Final Report 06-6648, Naval Air Development Center, Warminster, PA, May 1983.
23. "BMD Impact Phenomenology Data Base: Revised Bibliography," Parts 1 and 2, by J. S. Wilbeck and C. E. Anderson, Jr., SwRI-6567/3.1, Ballistic Missile Defense Advanced Technology Center, Huntsville, AL, January 1984.
24. "BMD Impact Phenomenology Data Base: Final Report," by J. S. Wilbeck and C. E. Anderson, Jr., SwRI-6567/4, Ballistic Missile Defense Advanced Technology Center, Huntsville, AL, June 1984.
25. "A Study of Intumescent Reaction Mechanisms," by C. E. Anderson, Jr., J. Dziuk, and J. Buckmaster, Report NADC-84170-60, SwRI Final Report 7557, Naval Air Development Center, Warminster, PA, August 1984.
26. "Thermal Response of an M55 Rocket to the Detonation and Burning of a Second Rocket," by D. E. Ketchum and C. E. Anderson, Jr., SwRI-8069/202, U. S. Army Corps of Engineers, Huntsville, AL, August 1984.
27. "Fire Modeling/Spread of Fire Effects from Room to Room," by A. F. Grand, C. E. Anderson, Jr., and D. K. O'Kelley, SwRI-9331, Southwest Research Institute, San Antonio, TX, December 1984.

28. "Thermal Response of M55 Rockets to Pool Fires During Transit," by D. E. Ketchum and C. E. Anderson, Jr., SwRI-8461/005, AMXTH-CD-TR-86057, U. S. Army Toxic and Hazardous Material Agency, Aberdeen Proving Ground, MD, April 1985.
29. "Numerical Analysis of Thermite Reaction," by C. E. Anderson, Jr., and S. T. Green, SwRI 7958/802.1, Naval Surface Weapons Center, China Lake, CA, October 1985.
30. "TTAI Technology Assessment of Kinetic Energy Kill Mechanisms," by E. Bergmann, N. Blaylock, and C. Anderson, SwRI Report 8897, The BDM Corporation, Huntsville, AL, February 1986.
31. "Numerical Analysis of Thermite Reaction: Part 2," by S. T. Green and C. E. Anderson, Jr., SwRI 7958/802.2, Naval Surface Weapons Center, China Lake, CA, February 1986.
32. "Finite-Difference Calculations to Support Flyer Plate Impact Experiments Against Soil," by C. E. Anderson, Jr., D. K. O'Kelley, and B. L. Morris, SwRI Report 8579/001, Air Force Weapons Laboratory, Kirtland AFB, NM, April 1986.
33. "HEMP Predictions of Wedge Test Fragment Velocity-Angle Distributions," by D. E. Ketchum, C. E. Anderson, Jr., and N. R. Ketchum, SwRI Report 8763/01A, prepared for New Technologies, Inc., Huntsville, AL, April 1986.
34. "Nondestructive Evaluation of Rocket Motors: Finite Element Analysis of Solid Propellant Failure," by S. A. Mullin, P. A. Cox and C. E. Anderson, Jr., SwRI Report 7858/802/1, Naval Surface Weapons Center, China Lake, CA, July 1986.
35. "Nondestructive Evaluation of Rocket Motors: Thermal Analysis of Rocket Cook-off," by S. T. Green and C. E. Anderson, Jr., SwRI Report 7958-802/3, Naval Surface Weapons Center, September 1986.
36. "Structural Failure Analyses of Filament-Wound Pressurized Cylinders Subject to CW Laser Irradiation," by J. W. Cardinal, P. E. O'Donoghue, C. E. Anderson, Jr. and M. F. Kanninen, SwRI Report 1122/1, AFWL-TR-87-48, Air Force Weapons Laboratory, Kirtland AFB, NM, October 1986.
37. "A Methodology for the Calibration of Soil Stress and Motion Instrumentation for Dry Soil," by C. E. Anderson, Jr., P. E. O'Donoghue and D. K. O'Kelley, SwRI Report 8579/002, AFWL-TR-87-70, Air Force Weapons Laboratory, Kirtland AFB, NM, May 1987.
38. "An Examination of the Explosive Launch of Cubical Tungsten Fragments," by C. E. Anderson, Jr., P. E. O'Donoghue and W. W. Predebon, SwRI Report 8763/01, U. S. Army Strategic Defense Command, Huntsville, AL, May 1987.
39. "Numerical Simulation of an Advanced Warhead Concept for Ballistic Missile Defense," by C. E. Anderson, Jr., D. E. Ketchum, N. R. Ketchum, P. E. O'Donoghue and D. K. O'Kelley, SwRI Report 8763/02, U. S. Army Strategic Defense Command, Huntsville, AL, July 1987.
40. "Prediction of a Blast/Fragment Loading on the Hull of a Bradley Fighting Vehicle," by J. P. Riegel, III, C. E. Anderson, Jr., K. Marchand, B. L. Morris, D. K. O'Kelley, R. Tullos and P. Westine, SwRI Report 1429, U.S.A. Ballistic Research Laboratory, Aberdeen Proving Ground, MD, April 1987.
41. "Fracture of Discrete Tungsten Fragments Under Explosive Loading," by C. E. Anderson, Jr., J. Lankford, and P. E. O'Donoghue, SwRI Report 8763/03, U. S. Army Strategic Defense Command, Huntsville, AL, October 1987.
42. "Explosive Loading of Metal and Composite Panels: Comparison of Experiments and Numerical Simulations," by C. E. Anderson, Jr., P. E. O'Donoghue, P. A. Cox and S. A. Mullin, SwRI Report 1882/003, FMC Corporation, San Jose, CA, January 1988.

43. "A Study of Formulations and Thermophysics of Intumescent Systems," by C. E. Anderson, Jr., J. Dziuk and D. E. Ketchum, SwRI Report 8766/01, Naval Air Development Center, Warminster, PA, September 1988.
44. "A Thermophysical Model for Intumescent Systems," by C. E. Anderson, Jr. and P. E. O'Donoghue, SwRI Report 8766/02, Warminster, PA, December 1988.
45. "Dissimilar Material Scaling Relationship for Hypervelocity Impact," by S. A. Mullin, C. E. Anderson, Jr., and J. S. Wilbeck, DNA-TR-89-112, Defense Nuclear Agency, Washington, D.C., February 1989.
46. "An Examination of the Stress Wave Profiles Resulting from Explosive Launching of Preformed Fragments: The Influence of Fragment Material and Spall Stress," by C. E. Anderson, Jr. and P. E. O'Donoghue, SwRI 3154/01, prepared for SPARTA, Inc., Huntsville, AL, January 1990.
47. "EPIC-3 Improvements and Ceramic Model Development (Rev. 1)," by G. R. Johnson, T. J. Holmquist, J. Lankford, C. E. Anderson, Jr., and J. D. Walker, Contract DE-AC04-87AL-42550/1, prepared for DARPA, Honeywell, Inc., Brooklyn Park, MN, February 1990.
48. "Impact Analysis: A Preliminary Analysis," by C. E. Anderson and J. D. Walker, SwRI Report 3154/02, prepared for SPARTA, Inc., Huntsville, AL, April 1990.
49. "Analysis of the Potential Survivability of a Preformed Tantalum Fragment to Explosive Launch," by C. E. Anderson, Jr., SwRI Report 3154/03, prepared for SPARTA, Inc., Huntsville, AL, June 1990.
50. "A Computational Constitutive Model and Test Data for Ceramics Subject to Large Strains, High Strain Rates, and High Pressures," by G. R. Johnson, T. J. Holmquist, J. Lankford, C. E. Anderson and J. D. Walker, Contract DE-AC04-87AL-42550/1, prepared for DARPA, Honeywell, Inc., Brooklyn Park, MN, August 1990.
51. "Long-Rod Penetration of Confined Ceramic Tiles," by C. E. Anderson, Jr., B. L. Morris, J. D. Walker and J. Lankford, ARO Final Report: DAAL03-88-K-0068, SwRI Report 2456/001, Southwest Research Institute, San Antonio, TX, March 1991.
52. "The Ballistic Performance of Confined Ceramic Tiles," by C. E. Anderson, Jr. and B. L. Morris, SwRI Report 2456/02, Southwest Research Institute, San Antonio, TX, April 1991.
53. "The Wilkins' Computational Ceramics Model for CTH," by J. D. Walker and C. E. Anderson, Jr., SwRI Report 4391/002, prepared for Teledyne Brown Engineering, Huntsville, AL, November 1991.
54. "A Penetration Mechanics Database," by C. E. Anderson, Jr., B. L. Morris, and D. L. Littlefield, SwRI Report 3593/01, prepared for DARPA, Southwest Research Institute, San Antonio, TX, January 1992 (AD-A246351).
55. "Velocity Scaling for Lethality Application," by S. A. Mullin, D. L. Littlefield, and C. E. Anderson, Jr., SwRI Report 4438, prepared for DNA, January 1992.
56. "Implementation of the Johnson-Holmquist Computational Model into CTH," by J. D. Walker and C. E. Anderson, Jr., SwRI Report 4522/109, prepared for Teledyne Brown Engineering, Huntsville, AL, January 1992.
57. "Strain-Rate Effects in Replica Scale Model Penetration Experiments," by C. E. Anderson, Jr., S. A. Mullin, and C. J. Kuhlman, SwRI Report 3593/02, prepared for DARPA, Southwest Research Institute, San Antonio, TX, August 1992.
58. "A Formulation for Treating Orthotropic Materials in Wave Propagation Computer Programs," by P. A. Cox and C. E. Anderson, Jr., SwRI Report 4738/006/2, prepared for Teledyne Brown Engineering, Huntsville, AL, November 1992.

59. "Implementation of the Rajendran-Grove Ceramic Model into CTH and EPIC 90," by J. D. Walker and C. E. Anderson, Jr., SwRI Report 4738/006/1, prepared for Teledyne Brown Engineering, Huntsville, AL, December 1992.
60. "Munition Procurement and Performance in Support of Armor Evaluation Testing," by C. E. Anderson, Jr., S. A. Royal, and J. P. Riegel, III, SwRI Report 4738/008, prepared for Teledyne Brown Engineering, Huntsville, AL, February 1993.
61. "An Investigation of Failure in Composite Plates Using a Modified EPIC92 Computer Code," by P. A. Cox and C. E. Anderson, SwRI Report 4738/012, prepared for Teledyne Brown Engineering, Huntsville, AL, June 1993.
62. "A Hypervelocity Experimental Research Database (HERD) in Support of The Code Validation Program (COVAL)," by B. Patterson, R. hunt, D. Brubaker, C. E. Anderson, Jr., E. S. Hertel, Jr., and S. A. Mullin, WL-TR-94-7024, Wright Laboratory Armament Directorate, Eglin AFB, FL, February 1994.
63. "Pretest Predictions of Long-Rod Interactions with Armor Technology Targets," by C. E. Anderson, Jr. and D. L. Littlefield, SwRI Report 07-5117, prepared for the U. S. Army Research Office, Southwest Research Institute, San Antonio, TX, April 1994.
64. "Scale Model Experiments with Ceramic Laminate Targets," by C. E. Anderson, Jr., S. A. Mullin, A. J. Piekutowski, N. W. Blaylock, and K. L. Poorman, SwRI Report 3593/004, prepared for the U. S. Army Research Office, Southwest Research Institute, San Antonio, TX, July 1994.
65. "Analytical and Technical Services in Support of Hypervelocity Impact," by B. G. Cour-Palais and C. E. Anderson, Jr., SwRI Report 07-5669, prepared for Lockheed Engineering & Sciences Company, Houston, TX, July 1994.
66. "A Numerical Study of the Penetration Physics of Asymmetric Long-Rod Projectiles at 1.8 and 2.6 km/s," by D. L. Littlefield and C. E. Anderson, Jr., SwRI Report 06-6716, prepared for Institute for Advanced Technology, The University of Texas at Austin, Southwest Research Institute, San Antonio, TX, March 1995.
67. "Computations and Model Development for Ceramic-Faced Light Armors," by J. D. Walker, C. E. Anderson, Jr., and P. A. Cox, SwRI Report 06-6700/001, prepared for US Army Natick Research & Development Engineering Center, Southwest Research Institute, San Antonio, TX, March 1995.
68. "Scale Model Penetration Experiments: Finite-Thickness Steel Targets," by S. A. Mullin, C. E. Anderson, Jr., A. J. Piekutowski, K. L. Poorman, N. W. Blaylock, and B. L. Morris, SwRI Report 3593/003, prepared for U. S. Army Research Office, Southwest Research Institute, San Antonio, TX, May 1995.
69. "Investigations of the Ballistic Response of Brittle Materials," by C. E. Anderson, Jr., J. D. Walker, and J. Lankford, SwRI Report 06-5117/002, prepared for U. S. Army Research Office, Southwest Research Institute, San Antonio, TX, November 1995.
70. "Residual Properties of Fragments Impacting Metallic and Composite Plates," by J. D. Walker and C. E. Anderson, Jr., SwRI Report 06-7573, prepared for Naval Surface Warfare Center, Southwest Research Institute, San Antonio, TX, July 1996.
71. "Investigations of Seg-Tel Penetrators," by C. E. Anderson, Jr., J. D. Walker, and T. R. Sharron, SwRI Report 06-6908/003, prepared for the Institute for Advanced Technology, The University of Texas at Austin, Austin, TX, September 1996.
72. "Performance of L/D 30 Tungsten Rods Against the One-Third Scale RHA Armor Technology Target at 1.8 km/s," by C. E. Anderson, Jr. and D. J. Grosch, SwRI Report 06-6908/002, prepared for the Institute for Advanced Technology, The University of Texas at Austin, Austin, TX, October 1996.

73. "Performance of *L/D* 30 Tungsten Rods Against the One-Third Scale Explosive Reactive Armor (ERA) Armor Technology Target at 1.8 km/s," by D. J. Grosch and C. E. Anderson, Jr., SwRI Report 06-6908/004, prepared for the Institute for Advanced Technology, The University of Texas at Austin, Austin, TX, December 1996.
74. "Predictions of the Effect of T/D on FATEPEN Fragmentation Velocities: Aluminum and Composite Panels," by C. E. Anderson, Jr., and James D. Walker, SwRI Report 96-8548, prepared for Applied Research Associates, Inc., Littleton, CO, January 1997.
75. "Analytical Modeling of Thin Ceramic Tiles Backed by Thin Substrates," by J. D. Walker and C. E. Anderson, Jr., SwRI Report 06-6700/2, prepared for U. S. Army Natick Research, Development, and Engineering Center, Natick, MA, April 1997.
76. "Hydrodynamic Ram: A Review of Experimental Data for Use in Validation of Numerical Simulations," by C. J. Freitas, C. E. Anderson, Jr., and D. L. Goodlin, SwRI Report 06-7365/001, prepared for Wright Laboratory (WL/FIVS), Wright-Patterson AFB, OH, April 1997.
77. "Numerical Simulations of a 23-mm HEI Impact and Detonation Experiment," by C. E. Anderson, Jr., J. D. Walker, G. I. Kerley, T. R. Sharron, and C. J. Freitas, SwRI Report 06-7365/002, prepared for Wright Laboratory (WL/FIVS), Wright-Patterson, AFB, OH, September 1997.
78. "Evaluation of a Ceramic Matrix Composite Material System as a Light-Armor Element," by C. E. Anderson, Jr., D. Yaziv, M. D. Ladika, S. D. Atmur, and B. Chen, SwRI Report 1147/001, prepared for U. S. Army Natick Research, Development, and Engineering Center, Natick, MA, December 1998.
79. "Penetrator Case Fracture Predictive Technology: Volume 1-Dynamic Fracture Mechanics Methodology," by C. H. Popelar, J. D. Walker, C. E. Anderson, Jr., G. R. Johnson, and S. R. Beissel, AFRL-MN-EG-TR-1999-7054, Air Force Research Laboratory, Eglin AFB, FL, June 1999.
80. "Penetrator Case Fracture Predictive Technology: Volume 2-Numerical Algorithms and Computations," by G. R. Johnson, S. R. Beissel, C. E. Anderson, Jr., C. H. Popelar, and J. D. Walker, AFRL-MN-EG-TR-1999-7054, Air Force Research Laboratory, Eglin AFB, FL, June 1999.
81. "WAPEN: Walker-Anderson Penetration Model Computer Program," by D. L. Goodlin, T. R. Sharron, J. D. Walker, and C. E. Anderson, Jr., Report TFLRF No. 99-004, prepared for U. S. Army TARDEC, Warren, MI, July 1999.
82. "HRAM Design Analysis: Engineering Approximations for Loading Functions," by C. J. Freitas and C. E. Anderson, Jr., SwRI Report 18/2279/001, prepared for Northrop Grumman, El Segundo, CA, November 1999.
83. "Residual Threat Analysis of Broken Long-Rod Projectiles," by J. D. Walker, D. L. Goodlin, and C. E. Anderson, Jr., SwRI Report 18-03410-1, prepared for TARDEC, Southwest Research Institute, San Antonio, TX, June 2000.
84. "Numerical Studies of Hydrodynamic Ram Experiments," by C. J. Freitas, C. E. Anderson, Jr., J. D. Walker, T. R. Sharron, and B. H. Thacker, SwRI Report 18-7365, prepared for Air Force Research Laboratory (WL/FIVS), Wright-Patterson AFB, OH, September 2000.
85. "An Investigation to Develop Ultra-Lightweight Armor," by C. E. Anderson, Jr., D. L. Orphal, G. R. Johnson, D. J. Grosch, and J. D. Walker, SwRI Report 18-1147-02, prepared for U.S. Army Biological and Chemical Command, Natick, MA, September 2000.
86. "Systems Requirement Document," by K. James, T. Warnagiris, P. A. Cox, D. L. Goodlin, and C. E. Anderson, Jr., SwRI Report 18.04212/001, prepared for Technical Support Working Group (TSWG), Arlington, VA, July 2001.

87. "Develop System Requirements Specifications (SRS) for a Bullet Countermeasure System," by C. E. Anderson, Jr., T. Warnagiris, P. A. Cox, and K. James, SwRI Report 18.04212/002, prepared for Technical Support Working Group (TSWG), Arlington, VA, Sept. 2001.
88. "Independent Evaluation of Solid Rocket Motor Reactivity Tests," by C. E. Anderson, Jr., C. J. Freitas, P. A. Cox, and T. R. Sharron, SwRI Report 18.4829, prepared for Litton/Ingalls Shipbuilding, Southwest Research Institute, San Antonio, TX, September 2001.
89. "Investigations of the MTrap™ Advanced Armor Concept," by C. E. Anderson, Jr., K. A. Dannemann, D. J. Grosch, D. L. Orphal, and E. J. Sagebiel, SwRI Report 03876/002, prepared for U.S. Army Soldier and Biological Command, Natick Soldier Center, Natick, MA, Feb. 2002.
90. "Analysis of the After-Interaction Debris Field from a Prototype AP System/Threat Interaction," by D. L. Goodlin, C. E. Anderson, Jr., and R. L. Mason, SwRI Report 18-03410-5, prepared for TARDEC, Southwest Research Institute, San Antonio, TX, July 2002.
91. "Calculation of Loads for the Townhouse Experiment in Support of the DD(X) Program," by C. E. Anderson, Jr., P. A. Cox, Christopher J. Freitas, Erick J. Sagebiel, T. R. Sharron, and J. D. Walker, SwRI Report 18.05927/001, prepared for Northrop Grumman Ship Systems, Pascagoula, MS, January 2003.
92. "Investigations of the Dynamic Intercept Advanced Armor Concept," by C. E. Anderson, Jr., R. F. Larriva, and G. R. Johnson, SwRI Report 18.03876/004, prepared for U.S. Army Soldier and Biological Command, Natick Soldier Center, Natick, MA, February 2003.
93. "Development of an Effector Launcher for Dynamic Intercept Armor," by C. E. Anderson, Jr., D. J. Grosch, K. D. McHenry, R. F. Larriva, F. Stecher, G. R. Johnson, J. Swenson, and D. L. Orphal, SwRI Report 18.03876/005, prepared for U.S. Army Soldier and Biological Command, Natick Soldier Center, Natick, MA, May 2003.

SPECIAL PUBLICATIONS, AWARDS, COMMITTEES AND COMMITTEE REPORTS

by

Charles E. Anderson, Jr.

1. *Tank Car Safety Through Research*, 22-1/2 minute color, sound film. C. E. Anderson, Jr., Technical Consultant, Herb Golden Organization, Sherman Oaks, CA, November 1979.
2. "Improving Railroad Safety Through Insulation Technology," by C. E. Anderson, Jr., **Army R, D, & A**, 21(2), March-April, 1980.
3. "Spot Size Requirements for Solid Booster Kill," LTH-1 Technical Action Group, SDI Lethality and Target Hardening Critical Issue Assessment, June 1985.
4. "Impulse Laser Spot Size for Solid Booster Kill," SDI Lethality and Target Hardening Critical Issue Assessment, June 1985.
5. *A Short Course on Penetration Mechanics: Course Notes*, by C. Anderson, J. Wilbeck, A. Wenzel, P. Westine, and U. Lindholm, Southwest Research Institute, San Antonio, TX, 1985-1990.
6. Technical Program Chairman, *1986 Hypervelocity Impact Symp.*, San Antonio, TX, October 21-24, 1986.
7. *Proceedings of the 1986 Hypervelocity Impact Symposium*, C. E. Anderson, Jr., Guest Editor, **Int. J. Impact Engng.**, 5(1-4), pp. 1-760, 1987.
8. "1986 Hypervelocity Impact Symp. Classified Proceedings," C. E. Anderson, Jr. and N. Blaylock (editors), DARPA-T10-87-02, Southwest Research Institute, San Antonio, TX, February 1987 (AD-C041378).
9. *DARPA Kinetic Energy Blue Ribbon Review Panel*, C. E. Anderson, Jr., Chairman, Los Alamos National Laboratory, October 17-21, 1988.
10. "Findings, Conclusions and Recommendations of the KE Impact Physics Review Panel" by C. Anderson, J. Asay, P. Boyd, H. Swift, and A. Williams, prepared for DARPA, January 1989.
11. *Ad Hoc Committee on the Computational Mechanics Program of BTI*, S. Nemat-Nasser, Chairman; C. Anderson committee member, January-May, 1989.
12. *Review Committee on Code Development and Material Modeling*, J. Immele, Chairman; C. Anderson, member, February-October 1989.
13. "Constitutive Models/Computational Mechanics Program of BTI: Report of the *Ad Hoc* Committee," by S. Nemat-Nasser, C. Anderson, S. Atluri, R. Asaro, G. Hegemier, T. Hughes, May 1989.
14. "Penetrating the Puzzles of Ballistics," by C. E. Anderson, Jr., **Technology Today**, 10 (2), June 1989.
15. "Report of the Review Committee on Code Development and Material Modeling," by J. Immele, C. Anderson, R. Asaro, S. Cochran, L. Davison, J. Foster, G. Johnson, G. Randers-Pehrson, J. Short, LA-UR-89-3416, Los Alamos National Laboratory, Los Alamos, NM, October 1989.
16. Technical Program Chairman, *1989 Hypervelocity Impact Symp.*, San Antonio, TX, December 12-14, 1989.
17. *Proceedings of the 1989 Hypervelocity Impact Symposium*, C. E. Anderson, Jr., Guest Editor, **Int. J. Impact Engng.**, 10(1-4), pp. 1-640, 1990.

18. "1989 Hypervelocity Impact Symp. Classified Proceedings," N. Blaylock and C. E. Anderson, Jr. (editors), DARPA-T10-90-02, Southwest Research Institute, San Antonio, TX, April 1990 (AD-
19. "Penetration Mechanics Research in the Former Soviet Union," by W. Isbell, C. Anderson, J. Asay, S. Bless, D. Grady and J. Sternberg, Foreign Applied Science Assessment Center, Technical Assessment Report, 1992.
20. "Early Times of Aerodynamics Ranges, Light-Gas Guns, and High-Velocity Impact," by A. C. Charters, C. E. Anderson, Jr. (Editor), The HVIS Distinguished Scientist Award, May 1992.
21. Best Paper Award, "Long-Rod Penetration, Target Resistance, and Hypervelocity Impact," *1992 Hypervelocity Impact Symp.*, Austin, TX, November 17-19, 1992.
22. *Proceedings of the 1992 Hypervelocity Impact Symposium*, C. E. Anderson, Jr., Guest Editor, **Int. J. Impact Engng.**, **14**(1-4), pp. 1-892, 1993.
23. Future Technologies Workshop, U. S. ARL and U. S. Army TARDEC, Aberdeen Proving Ground, MD, 9-11 June 1993, C. Anderson invited participant., "*Ideas from Future Technologies Workshop Held by ARL/TARDEC, June 1993*, ARL-SR-14, Army Research Laboratory, APG, MD, August 1994.
24. *Proceedings of the 1994 Hypervelocity Impact Symposium*, C. E. Anderson, Jr., Guest Editor, **Int. J. Impact Engng.**, **17**(1-6), pp. 1-948, 1995.
25. *Proceedings of the 1996 Hypervelocity Impact Symposium*, C. E. Anderson, Jr., Guest Editor, **Int. J. Impact Engng.**, **20**(1-10), pp. 1-876, 1997.
26. Best Poster Award, "Normalized Residual Lengths and Velocities as a Function of Projectile Strain-to-Failure," *17th Int. Symp. on Ballistics*, Midrand, South Africa, March 23-27, 1998.
27. Co-Chairman, *18th International Symposium on Ballistics*, San Antonio, TX, November 15-19, 1999
28. *Proceedings of the 1998 Hypervelocity Impact Symposium*, C. E. Anderson, Jr., Guest Editor, **Int. J. Impact Engng.**, **23**(1-10), pp. 1-1030, 1999.
29. **HVIS Distinguished Scientist Award**, for sustained leadership, innovation and technical excellence in hypervelocity research with special recognition for contributions to penetration mechanics, numerical simulation of penetration, modeling dynamic material response, and terminal ballistics, *2000 Hypervelocity Impact Symposium*, Galveston, TX, November 6-10, 2000
30. *Proceedings of the 2000 Hypervelocity Impact Symposium*, C. E. Anderson, Jr., Guest Editor, **Int. J. Impact Engng.**, **26**(1-10), 2001.
31. National Academies' *ARL Technical Assessment Board's Panel on Armor & Armaments*, C. E. Anderson, Jr., Panel Member, December 2001 – present.